Solar PV Water Pumping for Field Irrigation

With Variable Frequency Drive (VFD)

Factsheet

Aveyime, Volta Region (Ghana, June 2016)

Solar PV Water Pumping for Field Irrigation has become an increasingly feasible option due to the following facts: (1) Decreases in PV module prices (2) Increases in fuel and electricity prices (3) Advances in Inverter Technology (4) The usage of standard 3-phase industrial pump motors for larger systems. This factsheet provides a short overview of the technology.

What are the System Selection Criteria?

There is a combination of criteria to be considered. In order to achieve the best possible match for field irrigation the selection task must encompass and balance a number of system criteria. The core system selection criteria are summarised below:

- Availability of water
- Water demand (flow rate)
- Seasonal pattern of water use
- Ground water table (draw down level!)
- Pipe lengths and diameters
- Type of field irrigation technology
- Size of irrigation plot
- Types of crops to be grown

Each criterion (from list above) might be easy to assess, but the trick is to match all the criteria and weigh them up to achieve the best possible system fit.

Why not just use one Standard Irrigation System to meet all Irrigation Tasks?

This is technically not possible. There are no standard systems that automatically meet all the criteria mentioned above. Irrigation systems require a matching balance of different factors. In order to achieve such balance, the so-called 'System Selection Criteria' need to be considered individually.

Where do I start with Solar Field Irrigation?

(1) The start would be making a valid estimate of resources, checking the availability of water and comparing that with the water demand for the farmland.
(2) Then assign the right type of pumping system.
(3) Good cooperation between farmers, systems designers and implementing engineers has proved to be a key to success.

Variable Frequency Drive – a feasible Pump Technology

Variable Frequency Drive (VFD) has been designed in inverter technology to drive standard 3-phase industrial motors (and pumps) through efficiently converting DC power from Solar PV into 3-phase AC Power, 230V and 380V.

From the electro-mechanical point of view, VFD is a most suitable electrical power supply form; it guarantees the smoothest operation of heavy electrical machinery using 3-phase power. This is on a general note, since VFD has not been developed for Solar PV application but for industry. It has been patented in 1910 as *'useful application in supplying current to induction motors for driving cars, locomotives, or other mechanism which are to be driven at variable speeds'*. It is only in recent years that VFDs have become a useful application of

converting Solar (DC power) into 3-phase (AC power). In the past, the main obstacle to VFD was its high price, as compared to other motor drives. Prices of VFD Solar PV inverters have decreased considerably, making the technology now affordable for solar PV applications.

Pilot Project: 2.5 kWp field irrigation system using VFD and a surface water pump (Aveyime, Volta)

Variable Frequency Drive (VFD) in Solar PV

VFD has its advantages as well as limitations.

The main advantage is its high efficiency: the power conversion factor from DC to AC. In combination with an MPP (Maximum Power Point) tracker it guarantees a high system performance with very little electrical loss.

The disadvantage is that speed of any motor is variable (if application run by Solar PV); meaning that motor speed over time is never constant. The higher the solar radiation, the faster the motor runs (limited only by its nameplate speed). In a lower solar radiation scenario the motor runs on a lower frequency and with lower speeds yet with high torque and efficiency.

VFDs limitation to Solar PV powered applications therefore is limited to wherever a variable motor speed can be tolerated. This makes the technology useful for Solar Water Pumping, grain milling and any variable speed application you can think of.

With a focus on Solar Water Pumping, VFDs can run any type of surface or submersible pump, provided the pump motor using standard 3-phase 230/380V.

Running industrial heavy electrical motors / pumps on Solar PV

Conventional pump motors can easily run on Solar PV by using VFD drives. VFD drives are available from 1kW to 50kW and above. It is also possible to run such industrial electrical motors in a change-over-configuration in combination with either diesel generators or the existing electrical grid.

Change-over-Switch between PV Solar and ECG (Electricity Company Ghana) to run a 37kW irrigation pump via VFD control (Aveyime, Volta)

Components – Maintenance and Replacement

VFDs work on standard industrial motors/pumps and do not require special solar pumps. This makes maintenance easy (same maintenance as with grid-connected motors) and replacement easier, since standard industrial pumps are relatively cheap and widely available in developing countries, in contrast to solar pumps.

Pilot Project: Surface water irrigation system with surface pump on floating island (Aveyime, Volta)

The VFDs are quite robust and are generally maintenance free. The other system components consist of Solar PV modules and the conventional irrigation equipment. There are no other serviceable parts.

If the technology is that simple, why is Solar PV Irrigation yet in its infancy?

Solar PV irrigation suits its purpose best in tropical / semi-tropical regions. It just happens that those regions belong to developing countries where there is a lack of means to support such useful technological advancements. The so-called developed countries have not yet understood the huge potential of Solar Irrigation, which clearly stands for the global betterment of food supply and social equality.

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